Manitoba

Western Equine Encephalitis

Inter – Departmental

Review

Committee

May 1984

WESTERN EQUINE ENCEPHALITIS

EPIDEMIOLOGY

Western Equine Encephalitis (WEE) is a mosquito-borne virus infection of the brain of man and horses. The infection is fatal for the very young of a great variety of vertebrates but not the adults of most species. It is believed that the hosts of the virus are migra[illegible] birds. Human beings and horses become infected tangentially to the bird-mos[illegible] infection cycle and play no part in the further transmission of the disease.

Outbreaks in humans and horses occur west of the Mississippi River in agricultural valleys and the Great Central Plain and its environs.

The virus probably visits the Great Central Plain annually, but only causes epidemics in humans when certain conditions of moisture, temperature, mosquito and bird numbers are appropriate; epidemics are, in fact, sporadic and their location unpredictable in the Great Central Plain provinces and states (see Table I).

A very large epidemic occurred in the Great Central Plain in 1941 with over 500 cases in Manitoba alone and involving Saskatchewan, Alberta, Minnesota and North Dakota. An epidemic of this size has not been experienced since (see Table II); it is noteworthy that in the 33 years subsequent to that epidemic, no aerial spraying occurred in Manitoba.

Statistics show that the average number of cases of WEE have dropped in recent years in Canada and the United States. In Canada, the drop occurred in 1955 and has been maintained since; little change occurred with the introduction of aerial spraying in 1975.

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From U.S.A. statistics:

1955 - 1969	734 cases (49 / year)	range 21 - 172
1970 - 1983	244 cases (17 / year)	range 0 - 133

From Canadian statistics:

1941 - 1954	758 cases (54 / year)	range 4 - 526
1942 - 1954	232 cases (18 / year)	range 4 - 80
1955 - 1968	47 cases (3.6 / year)	range 0 - 9
1969 - 1983	65 cases (4.3 / year)	range 0 - 25

Not only does the incidence of the disease appear to be low, but the case fatality rate once quoted at 8 to 20 percent is now not in excess of 3 percent.

Epidemiological features indicate that the probability of a large epidemic is small and there is no evidence that the introduction of aerial spraying has altered the situation.

Table I

WESTERN EQUINE ENCEPHALITIS

1974 - 83

Great Central Plain

Human Cases

State or Province	74	75	76	77	78	79	80	81	82	83
Minnesota	0	15	0	9	3	0	0	0	0	1
Iowa	0	4	0	1	0	0	0	0	0	0
Missouri	0	0	0	0	0	0	0	0	0	0
N. Dakota	0	41	4	3	0	0	0	1	0	4
S. Dakota	0	28	0	3	0	1	0	0	0	1
Nebraska	0	12	0	0	0	0	0	1	1	0
Kansas	0	7	0	1	0	0	0	4	0	0
Manitoba	0	14	0	5	0	0	0	25	1	18
T O T A L	0	117	4	22	3	1	0	31	2	24

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Table II

REPORTED WESTERN EQUINE ENCEPHALITIS CASES

(There may be some variation in figures of reported cases according to source)

Year	U.S.A. 72-83	U.S.A. 55-71		Manitoba		
1941				526**		
42				45		
43				12		
44				10		
45				8		
46				6		
47				80		
48				5		
49				35		
50				5		
51				4		
52				5		
53				12		
54				5	758	232
55		37	(0)*	1	54/yr	18/yr
56		47	(0)	8		
57		35	(1)	8		
58		141	(2)	5		
59		14	(0)	6		
60		21	(0)	3		
61		27	(3)	0		
62		17	(1)	4		
63		56	(0)	9		
64		64	(7)	1		
65		172	(4)	0		
66		47	(2)	0		
67		18	(0)	2		
68		17	(0)	0	47	
69		21	(1)	1	3.6/yr	
70		4	(0)	0		
71		11	(1)	0		
72	8	749	(22)	1		
73	4	2.9%		0		
74	2			0		
75	133			14		
76	1			0		
77	41			5		
78	3			0		
79	3			0		
80	0			0		
81	19			25		
82	9			1		
83	6			18	65	
	229			870	4.3/yr	

Total U.S.A. = 978

* deaths

** 15% mortality

WESTERN EQUINE ENCEPHALITIS

AERIAL SPRAYING OF PESTICIDES

Without extensive epidemiological evidence, it is not possible to determine the effect of aerial spraying of insecticides on the spread of Western Equine Encephalitis (WEE), the evidence that it is or was effective must be indirect. In fact, the evidence rests solely on whether the aerial spraying significantly reduced the number of mosquitoes, particularly Culex tarsalis. If it can be shown that, in fact, Culex tarsalis were significantly reduced, it would be reasonable to conclude that a significant proportion of Culex tarsalis infected with WEE virus were also reduced and thereby the number of human (and equine) cases of WEE were reduced.

If the conclusion is reached that Culex tarsalis is not significantly reduced by aerial spraying, then aerial spraying, under these circumstances is not justified. It, therefore, becomes crucial to examine the evidence supporting the view that aerial spraying results in the significant reduction of Culex tarsalis in the circumstances surrounding the potential epidemic spread of WEE.

The kind of assumptions made in this paper are identical with the kind of assumptions made by those that support aerial spraying. We are ignorant of what combinations of the 50 biological and environmental factors that cause epidemics of WEE, therefore, speculation must be based on averages and it must be accepted that there are no better foundations for deciding for or against aerial spraying.

The total amount of exposure to WEE can be arrived at by assuming that 950,000 people in the southern part of Manitoba are exposed for a period of 60 days each summer to the possibility of being bitten by mosquitoes. Multiplication of these two figures give the person-days of exposure, i.e., there are 57 million person-days of exposure.

If we assume that one episode of aerial spraying causes a reduction in mosquitoes for a period of five days before infiltration of replacement mosquitoes from unsprayed areas takes place, we can calculate the person-days of protection using the population of the area sprayed. For example, Winnipeg (population 600,000) would have 5 x 600,000 = 3 million person-days of protection.

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If the afore-mentioned figures are expressed as a percentage of the total population at risk, then the protection provided by spraying Winnipeg once would be 3 million, expressed as a percentage of 57 million, which is just over 5%. This protection is reduced since the spraying program eliminated, at the most optimistic estimates, 80% of mosquitoes; thus, the 5% figure is reduced to just over 4%.

It is easy to see that aerial spraying of Brandon would contribute about one-quarter of a percent to the protection of the population of Manitoba. Similarly, aerial spraying of Niverville would contribute one-hundredth of one percent to the protection of the population of Manitoba.

If one carries out the above exercise with all the 32 places that were aerial sprayed in Manitoba (Winnipeg being done twice), the total amount of protection is at a maximum 10% of the total possible exposure.

The above conclusion has two important corollaries:

1) if a maximum of 10% protection was attained by the aerial spraying program, obviously no large epidemic would have occurred. This is in keeping with the epidemiological observations over the years.
2) if Winnipeg had been aerially sprayed twelve times, 63% protection would have been afforded for the population of Manitoba.

Other arguments in favour of aerial spraying appears to be by reference to published works: however, Ellis and Brust (1982), after quoting a series of references to ultra-low volume (ULV) insecticide applications, are careful to say: "The degree of success is usually based on entomological evaluation to measure reductions in vector mosquito activity and populations following treatment, epidemiological assessments rarely being made or reported". Thus confirming the opening paragraph of this paper.

Detailed review of the papers about aerial spraying with ULV shows that some (Mathis et al, Pant et al, Parker et al and Uribe et al) relate to situations in tropical countries where the mosquitoes, diseases and geography are all different from the Manitoba situation and furthermore, as stated above, none provide evidence of efficacy in stopping the spread of disease. One reports a mortality rate of mosquitoes as low as 70% for three days. The same kind of

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criticism may be levelled at the paper by Echevers et al where again, the disease and the species of mosquito are different from the Manitoba situation and the operation, which took place in Panama City, involved ground level spraying three times weekly: good mosquito control was obtained, but the paper is not relevant to aerial spraying in Manitoba.

One very positive paper is by Kilpatrick and Adams in the proceedings of the California Mosquito Control Association in 1967. Unfortunately, it is only one-half page and very little data is contained in it but it states that there was 90% reduction in mosquitoes and that human cases of St. Louis Encephalitis rapidly declined at an appropriate time after aerial spraying was initiated. Here again, the type of disease and the species of mosquito are different from the Manitoba situation.

As the result of Kilpatrick and Adams' report, C. J. Mitchell and his colleagues (which included the aforesaid Kilpatrick) studied ULV malathion by aerial application on some towns and areas in Texas and compared mosquito populations and virus activity in birds and mosquitoes with areas that had not been so treated. These workers make the following statements:

> "A significant reduction in the Culex tarsalis Coq. population level was evident only during the 48 hours immediately following treatment. Infiltration of adult mosquitoes from outside the treated areas was postulated to account for this rapid post-treatment population build-up. Seasonal WE virus infection rate in mosquitoes collected in treated and untreated towns did not differ significantly."

While the authors found a high level of virus activity in birds in one untreated area, it was as high in one treated area and low in other untreated areas; they conclude:

> "... therefore, factors other than ULV treatment must have been operative in keeping infection rates at a low level."

It is noteworthy that in the above study, from mid-June to the end of July, the spraying was done approximately weekly followed by two applications in August.

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Dr. William C. Reeves is a distinguished American scientist who was one of the first to isolate the WEE virus and (together with colleagues) his paper entitled "Analysis of the Circumstances Leading to Abortion of a Western Equine Encephalitis Epidemic" (1964) has been quoted in support of aerial spraying. However, examination of the original paper, shows the aerial spraying was used for larviciding water areas and not for adulticiding, which is the program carried out in Manitoba. The aerial larviciding was combined with ground fogging. The authors conclude:

> "From these observations we concluded that the magnitude of the epidemic (of WEE) was limited by a combination of low temperatures in the early summer... and successful control of the vector population in the urban area by midsummer."

It is noteworthy that, while some mosquito control activity occurred in rural areas, intense control activity (by ground level spraying) was applied to the urban area.

Reeves, in a more recent publication (1982), reviews generally the mosquito-borne arboviruses and comments on the North American viruses, including WEE, to the effect that to reduce the vector population to levels below that required for disease transmission:

> "... requires the establishment of a long range program of vector abatement backed up with a surveillance system and a capacity to act rapidly when environmental conditions provide a warning of impending epidemics that will require emergency abatement of large adult vector populations."

In the same publication, he mentions Manitoba and states that ULV aerial application of insecticides is "the current method of choice" and that elimination of the mosquito population "over a large geographic area for the 4 - 5 day period of viraemia in vertebrate hosts will eliminate the etiological reservoir and prevent new infections in the vectors and transmission to humans."

By "a large geographic area" presumably means large enough to prevent infiltration of replacement infected mosquitoes from unsprayed areas: the largest area sprayed aerially in Manitoba has been the City of Winnipeg whose

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largest radius is 10 miles, the distance that can be flown by a mosquito in a day. Apparently the author does not realize that aerial applications of insecticide have been made over a number of small areas in Manitoba instead of one large one. The figure of 450,000 hectares (over 1,000,000 acres) as being sprayed in Manitoba, which is quoted by Reeves, must have been a composite figure. Also, the claim that the elimination of the mosquito population for 4 - 5 days will prevent human infection does not appear to be supported by the published literature on the subject of aerial spraying in attempts to control encephalitis.

Finally, Reeves states in his 1982 publication:

"An effective adulticiding program should increase daily mortality to over 90% which should stop the viral transmission cycle." (the underlining is mine). This high mortality is frequently not reached according to the published literature including that relating to Manitoba.

In summary, arguments in favour of an aerial adulticiding program should be very carefully examined. Such programs may be justified under certain circumstances, but very careful consideration should be given to ensuring their effectiveness.

References

for

WESTERN EQUINE ENCEPHALITIS: AERIAL SPRAYING OF PESTICIDES

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POPULATION OF SPRAYED AREAS

(1983/4, 1984/5)

Steinbach/Ste. Anne	11,049	11,000
Morden/Winkler	10,345	10,000
Portage la Prairie	13,086	13,000
Carman	2,408	3,000
Selkirk	10,042	10,000
Stonewall/Stony Mountain	3,789	4,000
Niverville	1,329	2,000
Morris	1,570	2,000
Altona	2,757	3,000
Gimli/West Beaches	2,899	3,000
Oakbank/Dugald	1,687	2,000
Beausejour	2,417	3,000
Brandon	37,846	40,000
Dauphin	9,164	10,000
Virden	3,145	4,000
Swan River	4,656	5,000
Roblin	2,242	3,000
Russell	1,875	2,000
Deloraine	1,176	2,000
Melita	1,315	2,000
Minnedosa	2,895	3,000
Neepawa	3,746	4,000
Grandview	1,040	2,000
Ste. Rose du Lac	1,232	2,000
Boissevain	1,716	2,000
Killarney	2,476	3,000
Winnipeg x 2	594,701	600,000
	732,603	600,000
		1,350,000

A. Estimate of Population of Southern Manitoba

(Figures from M.H.S.C.)

Population of Manitoba		1,086,109
Unorganized Territories	11,372	
Indian Bands	47,039	
Norman	21,941	
	80,352	80,352
Estimated southern Manitoba		1,005,757
For the purposes of calculation, use ...		950,000

(reduction of 5.5% and southern Indian Bands)

B. Calculation of "Person-Days Exposure"

to

Western Equine Encephalitis

Population of 950,000 for 60 days = 57,000,000 person-days exposure

C. Calculation of Theoretical "Person-Days Protection"

Afforded by Aerial Spray Program Against

Western Equine Encephalitis

Total population sprayed = (counting Winnipeg twice)	1,350,000
Increase by 10% to include all population in spray zone =	1,485,000
No. of effective days of protection =	5
Person-Days Protection (1,485,000 x 5) =	7,425,000

D. Calculation of percent of protection
of all Manitobans exposed to
Western Equine Encephalitis

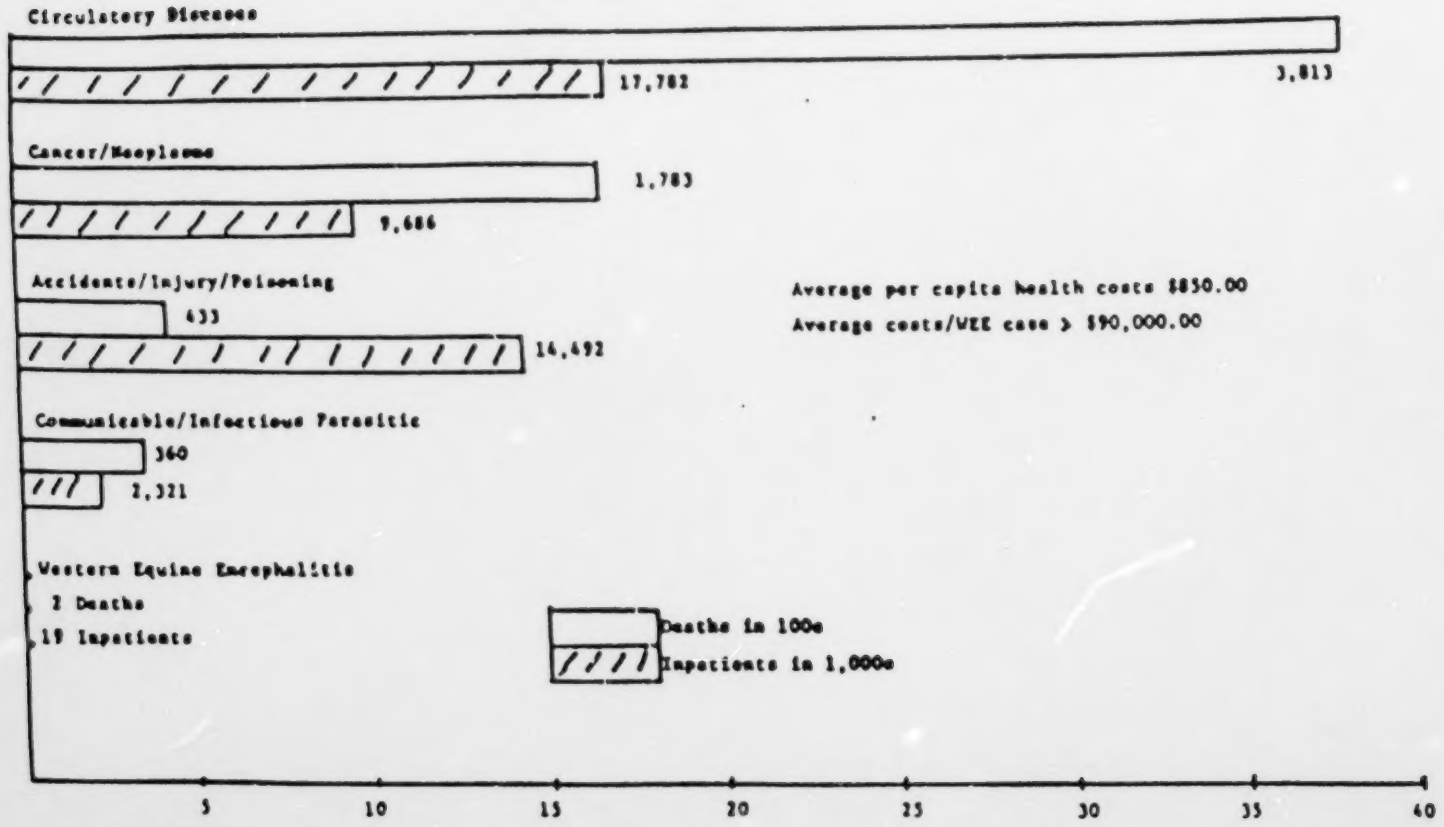
Percent protection is "person-days protection"
divided by "person-days exposure" times 100.

100 (7,425,000 ÷ 57,000,000) = 13%

But the spray is only (at best)
80% effective against mosquitoes

80% of 13% = <u>10%</u>

WESTERN EQUINE ENCEPHALITIS
AERIAL SPRAYING 1981
DEATHS, INPATIENTS AND COSTS



Average per capita health costs $850.00

Average costs/WEE case > $90,000.00